# Driven by steel

## SX1-Southern Cross Development – East Tower



An exciting new business development is taking shape in Melbourne at the top end of Bourke Street on the western corner of Exhibition Street. This prominent site was the location of Melbourne's once prestigious Southern Cross Hotel. The site was procured by joint venture partners and is now under the ownership of Multiplex. The current phase of the project is due for completion in March.

The new Southern Cross Development is well located at the eastern precinct of the Melbourne central business district. The site also enjoys excellent amenities with shops, restaurants, hotels, major office buildings and public transport nearby.

The trend for modern corporations to seek larger floor plates rather than skyscrapers was a driving force in the commercial brief of this new corporate building. The target market is a mix of corporate and government tenants.

Planned to be staged, the development of two building towers linked with Southern Cross Lane under the canopy and five basement levels, will offer to the market 120,000 square metres of office space in total, over 5,000 square metres of retail space and secure parking for 950 cars, 150 bicycles and 100 motor bikes.

The building, labelled SX1, will comprise four major elements:

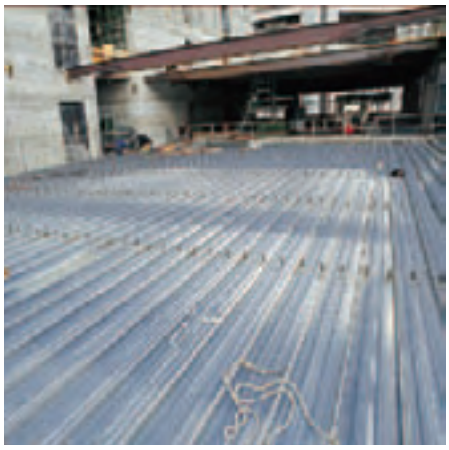
- double height ground level consisting of main entries, foyer and secured lift lobbies, whilst the remaining space will be offered for mixed use retail
- above ground level, two podium floors providing 3,500 square metres of Net Letable Area (NLA) of office area each
- elegantly constructed and transparent canopy enclosing the space between the buildings at the top of their podium levels will open up to new civic and retail precinct labelled Southern Cross Lane
- the tower above the podium levels will have open office floor plates larger then 2,100 square metres and will accommodate plant rooms and required building services.

Distant night shot of the almost completed project.

The SX1 (or East Tower) with centrally located concrete core and only one row of columns to building perimeter will deliver 76,700 square metres over 40 floors. The SX2 (or West Tower) with side core and two rows of columns (perimeter and centre of building) will provide 45,200 square metres over 22 levels will occupy the western end of the site in the future.

Stage 1 of the development, fully let to the Victorian State Government, includes the construction of five levels of basement carparking below street level and the 40 level (165 metre high) East Tower – SX1. Multiplex Construction is the 'design and construct' builder for this $300 million development. It is estimated that 40,000 cubic metres of concrete and 6,500 tonnes of steel will be used on the project.

Woods Bagot has designed a dramatically angled glazed façade, to take advantage of the city view.



Structural flooring system showing steel decking.

Woods Bagot, the architect on the projects, has designed a dramatically angled glazed façade, to take advantage of the city views. Gordana Ticak, Woods Bagot's Project Director said that: "On the eastern façade we utilised the slim profile of the slab (Stramit Condeck® with125PFC edge beam) and floor structure to extend glazing from floor to underside of slab above thus maximising the views and natural light penetration. The steel structure and the beams cantilever has enabled creation of large podium floors, giving a dramatic affect of space without any apparent support."

Lift shafts, toilets, lobby and escape stairs were located centrally within the floor plates, with columns located at the building's perimeter, creating column-free space. The floor plates for the building are approximately 4,300 square metres through the podium levels (levels one to four), while the typical floors are approximately 2,650 square metres.

The 14 metre typical span was a massive selling feature for SX Developments and enabled work station layouts at a 1,500 millimetre grid rather than 800 or 900 millimetres. This significantly improvedbuilding efficiency.

The structural solution for the tower floor plate needed to accommodate spans of up to 16 metres radiating from the central core. Multiplex Constructions required the structure be simple, easy to construct, repetitive and minimise the on-site trades. Formwork construction prices are fluctuating in response to the market demand in and around the Melbourne central business district.

Durham Shaw, Multiplex Constructions' Design Manager on the site, said that the two main drivers for steel were the price of formwork and the competitive quotes from the steel fabricators.

Durham said that GVP Fabricators, engaged as the steel fabricator and erector, conducted the operation in a highly professional manner. "There was no previous relationship with the site team but some relationship with Multiplex. The Multiplex site team was relatively unfamiliar with high rise structural steel construction so the key was in the professional shop detailing, and GVP facilitated this. The big advantage in building in steel is floor turnaround time. With steel you can move the screens the next day whereas with concrete screens cannot move until the back-propping is complete and the concrete has had sufficient time to cure."

"The other great advantage was the reduction in the number of workers on site. On this project the erection team was 15 whereas if the building had been a concrete frame the number of form workers would have been approximately 80," Durham said.

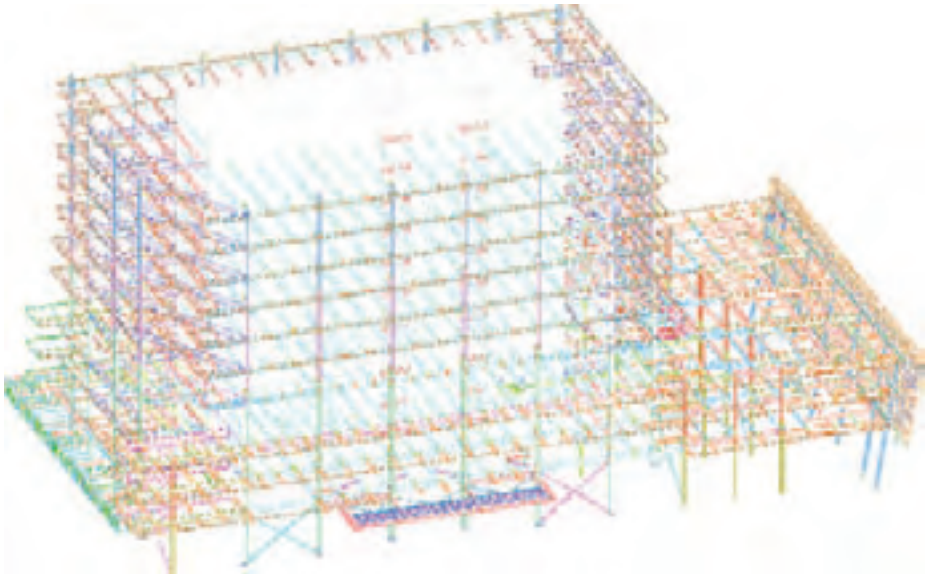
Bonacci Group (structural engineers on the project) Director Stuart Rossiter, proposed an unpropped steel frame, acting compositely with metal deck formwork as the most cost-effective solution for the tower, and this was then verified by Multiplex Constructions. Columns were spaced around the building's perimeter, at 9 metre centres, to suit the architectural ceiling and façade grid and there are no column transfers.

The structure below, and including ground floor, is insitu slabs and band beam construction. This was to give the below ground structure, which is visible, a more harmonious and safer feel.

**Steel detailing**

Steel detailer Ricky Hains of PlanIT Design Group said they created a 3D model for the project using ProSteel 3D detailing software. "To ensure that the correct amount of precamber was being applied to the steel floor beams, a bay of steelwork was actually assembled at GVP's plant and then loaded with steel plates to simulate the loading from wet concrete. The amount of deflection was then measured and compared to the theoretical deflection previously calculated. The fact that the measured figures were all within an acceptable range of the theoretical figures is testament to the level of engineering expertise employed on this project".

"Apart from the steelwork supporting the façade work on the first four levels where there were some interesting geometric requirements, the detailing was relatively straight forward. One variable that had to be considered was the impact of the axial compression on the



PlanIt Design created a 3D model of the project shared by all contractors using ProSteel 3D

steel columns with an extra 2 millimetres added to the height of the columns for each floor. Multiplex's use of a web based project management program 'Aconex' facilitated the exchange of documentation and helped coordination between the various sub-contractors, including those working on the façade glazing and the steel structure."

**Structural steel design**
Lou Piovesan, Director at Bonacci Group described the design of the columns, slab and beams of the structural system.

**Columns:** "Full structural steel columns were adopted in lieu of composite action or erection column encased in concrete. This enables the structural column to be relatively small in size. Standard sections produced by OneSteel, however, did not have the capacity to support the imposed axial loads, so we designed a fabricated column section, made from 400 grade steel plate, with the capacity to support the large axial loads."

Extended glazing from floor to the underside of the slab above maximises the views and natural light penetration.

GVP Fabricators, the steel fabricators and erectors for the project, had problems with Australian steel suppliers manufacturing these columns and looked overseas for a solution. 460 Grade hot rolled sections were sourced, shipped from Germany, and used for 28 levels of the building. Smorgon Steel Metals Distribution supplied 1,155 tonne of imported hot rolled sections and 5,345 of Australian hot rolled and welded sections.

Generally, the columns were erected three storeys high, with splices at 1,000mm above the finished floor level. Splices were designed in accordance with AS 4100-1998 Steel Structures Code. The ends of columns were prepared for full contact with splice plates designed to transmit nominal axial compressions and minimum moments. Adjustments to the column heights were made to control the differential settlement between the concrete core shortening and creeping and shortening of the steel columns.

**Slabs:** Continuous metal deck formwork spanning 3,000 millimetres between secondary beams was used to support the 120 millimetre thick floor slab, with continuous top reinforcing fabric. In areas where greater acoustic requirement was required (such as plant rooms), a thicker slab with secondary beams at closer centres was adopted.

**Beams:** The building floor framing system has composite steel secondary beams spanning up to 15 typical metres. Lou said that: "These were pushed out to 3,000 millimetre centres to optimise the span of the metal deck formwork, with cantilevers varying from 1,000 millimetres above level five and 4,000 millimetres between level two and level four."

"The cantilevers rely on beam continuity through the primary support beams," Lou said. "To control tip deflections Multiplex elected to prop the ends of the beams, which was critical because of the method of fixing the curtain wall system. Steel channels were cast into the slab, so that the curtain wall could effectively be fixed to the building, controlling the tip deflections. There were no penetrations in the beams but a services haunch around each beam. The secondary beams were also notched at each end, to assist in services reticulation for the building. Beams are supported by the concrete core at one end and steel primary beams at the other."

"Composite primary beams spanning between the steel columns support the secondary beams and gave the structure a degree of rigidity during erection and pouring of slabs."

"Connection details needed to be simple to reduce erection time of structural members on site. We designed bearing plate connections for primary beams, simple cleated connections for secondary beams and end plates, where continuity was required," Lou concluded.

## Advantages of the steel solution

**Cost:** The unpropped steel acting compositely with metal deck formwork was the most cost-effective solution for the tower.

**Ease of construction:** The steel solution was simple, easy to construct, repetitive and minimised the on-site trades.

**Reduced workforce:** The reduction in the number of workers on site made for a safer and less congested site. Erection team was 15 as opposed to around 80 formworkers.

**Flexiblity:** The flexibility of steel allowed the architects to design a dramatically angled glazed façade, to take advantage of the city views.

**Metal deck:** The slim metal deck (Stramit Condeck® with125PFC edge beam) and floor structure enabled the architect to extend the glazing from the floor to the underside of slab above, maximising the views and natural light penetration.

**Technology:** Creating a 3D model of the project allowed web-based document exchange facilitating accuracy and reducing the number of Request For Information (RFI).

**Time:** Big advantage in steel is floor turnaround time.

**Large spans:** The 14 typical metre spans enabled work station layouts at a 1,500 millimetres grid rather than 800 millimetres or 900 millimetres significantly improving building efficiency.

**Off-site construction:** Off site construction of the structural steelwork reduced traffic and site congestion.

**Industry capability:** Competitive steel fabrication industry. High professionalism of the steel fabricator and their facilitation of the professional shop detailing,

The podium levels of the new SX1 Development take shape.

**Fire engineering design**

A thorough fire engineering design was investigated by Lincolne Scott Fire, all working through the building surveyor, Philip Chun and Associates. The investigation considered all the other services, such as sprinklers, smoke detection, and hydrants that also fire protect the building. The fire engineering solution adopted to comply with the requirements of the Building Code of Australia (BCA) was to fire protect all steel columns to the underside of primary beams, as well as primary beams with a surface area to mass ratio of greater than 20 square metres per tonne. The fire engineering study reduced the protection from two hours to one hour through larger exits. This solution was an economically acceptable outcome as most of the structural steel was unprotected.

**Environmental**

Lou said that: "This building is unique, in that Woods Bagot has implemented a number of environmentally sustainable development (ESD) initiatives, such as double glazing and double skin facades. We have recycled steel off-cuts, black water treatment and, where possible, used environmentally friendly material."

"The ESD façade provided the design team with some challenges, in particular to support the outer façade skin. We also needed to maintain access between the two facades. This was achieved by extending the floor plate structure beyond the concrete edge, in order to support the walkway between skins, while at the same time carrying the vertical and horizontal load imposed by the external façade."

**Conclusion**

Lou Piovesan, Director Bonacci Group said that: "To achieve the maximum benefit for structural steel framed buildings a more active role during the design phase should be played by the steel fabricator/erector and steel detailer so that systems of repetition, optimised connection design and planned erection sequencing can be implemented that best suits the capabilities of the fabricator. This, however, does mean engaging the fabricator before the design is finalised. Builders are always nervous about this, as it eliminates the opportunity for competitive tendering."

"A better understanding early in the design phase of external façade systems would greatly assist designers in optimising and detailing systems that accommodate façade system tolerances and fixing requirements. Again, this limits the builder getting competitive tender prices for the work, if the manufacturers and installers are employed at the beginning of the project, before the design is fully scoped."

"The other challenge, not only with steel framed structures but all construction, is that change to the floor plate is difficult to incorporate once construction begins. With steel it is because once steel fabrication begins, the steelwork is manufactured a number of floors ahead of construction. Late changes, which require modification on site, can be very expensive but are easier to accommodate in steel than, say, concrete."

Lou concluded his comments on this project by saying that: "Bonacci Group has, over recent years, established an enviable track record in designing and delivering a varied range of steel framed structures. We recognised that pre-planning is paramount in achieving and delivering the project on time and on budget. It is through getting the project team working closely together at the initial planning phase that determines the success of the building system adopted. We were fortunate that architectural issues were addressed and accommodated early, as well as the services requirements for plant, duct work and penetrations."

"If the building can be planned and understood and all interfaces between the owners, consultants and builder co-ordinated early during the design phase, then the advantages of opting for a structural steel building system can be realised."

"Bonacci Group would have no hesitation in repeating the exercise, given the success of this project."

**Project Team**

**Developer:** SX Developments
**Building Contractor:** Multiplex Constructions
**Architect:** Woods Bagot
**Structural Engineers:** Bonacci Group
**Steel Contractor:** GVP Fabricators
**Steel detailing:** PlanIt Design Group
**Steel supplier:** Smorgon Steel Metals Distribution